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BIOC 415 : EXPERIMENTAL PHYSIOLOGY Spring 2017

Course Details

Details are subject to change at the instructor's discretion.

Instructor and office hours

Instructor: David R. Caprette, Ph.D.
Teaching Professor, BioSciences
Office and contact information: ABL 327, caprette@rice.edu, x3498
Hours variable (see table at the bottom of this page)

Brief description

In BIOC 415 (Experimental Physiology), teams of students explore the properties of excitable cells and the mechanisms behind those properties. Experimental studies focus on the origin of membrane potentials, generation/propagation of action potentials and properties of nerves, and mechanisms for controlling muscle contractile strength. Each study begins with a student-led discussion of principles/concepts, questions to be asked and to be addressed experimentally, available methodology, ides for analyzing data, and experimental strategies. We will follow each study with discussion of the data collected by the teams, possible conclusions and/or changes to our plans for data analysis, and what information we might draw from the data.

Expectations

NOTE: This course begins with a significant amount of pre-class preparation and a quiz on the first day. To help you prepare, please read the file "Day1prep.pdf" in the prep guides folder in Resources.

BIOC 415 is a "capstone" laboratory course, meaning that students are expected to apply previously learned skills to new studies. As a student in BIOC 415 you are expected to:

- Apply the strategies for learning difficult concepts that you have acquired from your prior course work and/or other experiences toward an understanding of the concepts behind membrane resting potentials, generation and propagation of nerve action potentials, and the electrical and mechanical properties of muscle
- Be prepared to lead a class discussion of any of the concepts, including specific questions that have been posed to the class

- Be prepared at any time for a quiz to assess your preparation for class and/or ability to apply concepts and principles that we have discussed in a prior class
- Take a goal-oriented approach to the laboratory work by developing hypotheses and experimental protocols with which to test them
- Collect, record, share, and analyze data using the best practices that you have acquired in previous lab courses and/or independent study
- Apply best practices for writing text and preparing figures in order to present your findings in publishable form (Results)
- Write up interpretations that address the questions that we explored through experimentation and explain the findings in terms of physical/molecular mechanisms (Discussions)
- Adhere to the spirit, not just the letter, of the honor code

Course grade

Each assignment will receive a score on a percent scale, to be recorded in the Gradebook. After weighting and averaging all scores we will assign letter grades as described in the table below.

A+, ≥ 97	B+, 87-90	C+, 77-80	D+, 67-70
A, 93-97	B, 83-87	C, 73-77	D, 63-67
A-, 90-93	B-, 80-83	C-, 70-73	D-, 60-63
			F, ≤ 60

Assignments will contribute to the final course grade in the following proportions. See the detailed meeting schedule for assignments and due dates.

Quizzes, experimental protocols, laboratory work, 40%

All items count equally toward the average score for this part. Expect about four quizzes total, some to be unannounced. Criteria for scoring experimental protocols will include: all elements included; well stated objective (testable hypothesis or question); clear and accurate description of how the plan will accomplish the objective; plans for data analysis and for collecting data should accomplish the objective. The quality of laboratory work will be assessed in part by the quality of data collected. Were you able to complete the work? Do the data collected reflect a complete and accurate understanding of the background concepts and goals of the study? Will you and members of other teams be able to use your data to address the study's objectives?

Two research papers (results and discussion only), 60%

Each of the two Results sections and two Discussion sections will count toward 15% of the final grade.

Criteria for grading results and discussions will be similar to criteria employed in Bioc 211 and 311. Papers may be submitted as hard copies (preferred) or as electronic submissions sent as email attachments. To permit anonymous grading, please put your identifying information on a title page and begin the body of the paper on the second page. Do not include any identifying information on any page except for the title page (no name, initials, ID…).

Policies

On time attendance is required, and makeup labs are not possible. Some class meetings will begin with an unannounced quiz with a time limit. Missed quizzes cannot be made up. The class and instructor will decide on the due date for the second research paper. Once the due date is set the usual late policy applies. The grade for any late assignment will be reduced by 10% for each day or part of day past the original due date and time. For example, if the paper is due at 1 pm in class and is received that evening, the grade will be reduced by 10%. If it is received after 1 pm the following day the deduction will be 20%. Saturdays, Sundays, and holidays count. Electronic submissions are

accepted.

Honor code policy

The Rice honor code applies to all assignments in this course. Students will work together to plan and conduct experiments and to compile raw data. In class we will discuss how to analyze the data and interpret the findings, and you are free to continue such discussions outside of class. You may want to share ideas on how to convert raw data to a presentable form, statistics or visual elements (e.g., graphs) to employ, what the findings mean, mechanisms that explain the findings, etc. Collaboration is to be limited to discussions only. **Aside from sharing your ideas, the final work must be your own work, in entirety. There is to be no co-writing of experimental designs or papers, paraphrasing of other students' work, or sharing of figures or tables.** Students are not to allow access by other students to any of their work whether it is in preparation or in final form.

Students with disabilities

Any student with a documented disability needing adjustments or accommodations is requested to speak with Dr. Caprette during the first two weeks of class. All discussions will remain confidential. Such students should also contact Disability Support Services in the Ley Student Center.

Meeting schedule

The table immediately below this paragraph is an abbreviated schedule. Please see the Detailed Schedule (next section below) for an itemized list of reading assignments and activities, including assignments and documents to consult as you prepare for class. Note that there will be a quiz on the first day. Remaining quizzes will be unannounced. All classes will begin at 1 pm unless otherwise noted. Due to University obligations your instructor will join you around 2 pm on Jan 11 & 25 and Feb 8.

Day/date/time/place	Topic
Mon Jan 9, 1 PM, ABL 329 then on to ABL 219	Course introduction, quiz, student-led discussions of background material, software tutorial
Weds Jan 11, 1:30 PM, ABL 219	First membrane potential lab
Monday Jan 16 MLK HOLIDAY	
Weds Jan 18, 1 PM, ABL 219	Second membrane potential lab
Mon Jan 23, 1 PM, ABL 329	Followup on membrane labs
Weds Jan 25, 1 PM, ABL 219 then on to ABL 329	Introduction to nerve recording and software tutorial (Scope)
Mon Jan 30, 1 PM, ABL 219	Nerve lab 1
Weds Feb 1, 1 PM, ABL 219	Nerve lab 2
Monday Feb 6, 1 PM, ABL 329	Follow up nerve labs
Weds Feb 8, 1 PM, ABL 219 then on to ABL 329	Introduction to nerve/muscle studies
Mon Feb 13, 1 PM, ABL 219	Muscle lab 1
Weds Feb 15, 1 PM, ABL 219	Muscle lab 2
Mon Feb 20, 1 PM, ABL 329	Follow up muscle labs

Detailed schedule for spring 2017

In the Resources section you will find guides to preparing for class, a laboratory manual, a set of Appendixes, materials on basic electricity, PowerPoint notes pages on selected topics, and a list of questions to be addressed in class. I will also post class data sets as you generate the data in lab. All data are the property of the entire class and should be used, selectively, for your final papers.

Each assignment is to be uploaded to your Drop Box by the date & time due.

Day/time/place/topics	Activities
Day 1 Monday Jan 9, 1 PM Course introduction, prepare for studies on the origin of the membrane potential ABL 329 (discussions) ABL 141 (software training)	*Preparation (in advance of the first class meeting)* • Review the materials described in the document Day1prep.pdf, posted in Resources and be prepared for a 20 question *closed notes* quiz *Introduction and quiz (ABL 329)* • Introductions - names, majors, why you are taking the course • Decide on team assignments • Quiz on preparation for day 1 • Review quiz answers • Course introduction including lab studies, assignments, grading *Student-led discussion* • Discuss equilibrium potentials (Equilibrium_potential.pdf) • Discuss the electrogenic property of the sodium pump (Discovering.pdf) • Discuss the use of microelectrodes for measuring membrane potentials (Microelectrodes.pdf) • Plan the laboratory work to study the electrogenic contribution of the sodium pump in crayfish extensor muscle *Guided discussions* • A/D recording, data to be recorded, transducers, calibrating and using an IC probe • Preparing an experimental protocol *Learn the data acquisition software (ABL 219)* • Self-paced tutorial on using the AD Instruments Chart software • Learn to calibrate an IC probe and measure electrode tip resistance
Day 2 Wednesday Jan 11, 1:30 PM First membrane potential lab ABL 219 (discussion and lab work)	*Preparation* • Review the documents Learning_physiology and Em_study_prep (prep guides folder in Resources) and prepare for Day 2 as suggested *Student-led discussion (ABL 219)* • Briefly discuss the questions posed for today, starting promptly at 1:30 pm; identify any concepts needing clarification • Bring any conceptual issues or concerns to the attention of your instructor, who will join you some time between 2 and 2:15 pm, if not earlier

	Laboratory (ABL 219) • Demonstration of crayfish dissection, measuring a membrane potential • Precautions when using microelectrodes and holders • Troubleshooting suggestions • Students: measure control E_m values and short term effect of ouabain on E_m *Followup* • Email today's results (raw data) to the instructor by the end of the day
Monday Jan 16	**MLK HOLIDAY**
Day 3 Wednesday Jan 18, 1 PM Second membrane potential lab ABL 219 (discussion and lab work)	*Preparation* • Again review the document Em_study_prep in the prep guides folder in Resources and prepare for class as advised in the Day 3 section *Student-led discussions (ABL 219)* • Address today's questions – conclusion from the ouabain study, conducting today's experiments *Laboratory (ABL 219)* • Dissect crayfish, measure E_m in variable K^+ and Na^+ solutions *Followup* • Compile your data and send to the instructor by the end of the day
Day 4 Monday Jan 23, 1 PM Discuss findings from the membrane labs and their interpretation ABL 329	*Preparation* • Review the relevant parts of Em_study_prep with emphasis on Day 4 and be prepared for the discussions (and possible quiz) *Student-led discussion* • Share ideas for analyzing, presenting, and interpreting the data from the experiments with membrane potentials • Discuss the questions posed for today Your first results section will be due in one week, at the start of class – for suggestions please see the document Writing_papers in the prep guides folder.
Day 5	*Preparation*

Wednesday Jan 25, 1 PM Learning to use the Scope software; introduction to the nerve studies ABL 219 (software training) ABL 329 (discussion)	• For a good start toward learning properties of vertebrate nerves, prepare for class as recommended in the document Nerve_lab_prep, Day 5 guidelines *Learn the data acquisition software (ABL 219)* Please begin at 1 pm by going through the self paced tutorial on using the Scope software. If you finish before 2 pm then please wait in the break area outside of ABL 329 until the previous group has left the room. Your instructor will join you some time between 2 and 2:15 pm, if not earlier. *Student-led discussions (ABL 329)* • Initiation and propagation of action potentials • Differences between a compound action potential and a single action potential • Introduce the recruitment study; what will you be doing and why? • Introduce the strength-duration experiment and its rationale *Guided discussion* • Why was it necessary to abandon the equilibrium potential model? • Recording a compound action potential
Day 6 Monday Jan 30, 1 PM Nerve lab 1 ABL 219	*Preparation* Upload complete results section from the membrane studies into your Drop Box before the start of class • Prepare for class as recommended in the document Nerve_lab_prep, guidelines for Day 6 *Laboratory* • Instructor demonstration: dissection, chamber preparation, recording a CAP • Prepare nerve, collect recruitment and S-D data • Time permitting, explore nerve properties, including velocity, refractory period, start planning data collection for next time *Followup* • Send raw data to the instructor within 24 hours
Day 7 Wednesday Feb 1, 1 PM Nerve lab 2 ABL 219 (discussion and lab work)	*Preparation* • Prepare for class as recommended in the document Nerve_lab_prep, guidelines for Day 7 *Student-led discussions (ABL 219)* • Share your plans for analyzing the recruitment and

	strength-duration data • Discuss the function of a myelin sheath, saltatory conduction, and why some axons conduct faster than others • Discuss the rationale behind absolute and relative refractory periods • Share plans for the studies on conduction velocity and estimating a refractory period *Laboratory (ABL 219)* • Estimate conduction velocities using alternative methods • Conduct two series of refractory period experiments, one with threshold stimulus, one with suprathreshold stimulus • Explore changes in properties of the compound action potential with the nerve partly blocked with lildocaine *Followup* • Send raw data to the instructor within 24 hours • Prepare a preliminary analysis of all of the nerve study data
Day 8 Monday Feb 6, 1 PM Follow up the nerve labs ABL 329	*Preparation* • Prepare for class as recommended in the document Nerve_lab_prep, guidelines for Day 8 *Student-led discussio*n • Share your findings, explanations, mechanisms, and significance, one experiment at a time • Share your ideas for the best ways of presenting the findings in text and as figures Your discussion of the membrane lab findings will be due in one week
Day 9 Wednesday Feb 8, 1 PM ABL 219 (calibration) ABL 329 (discussion) calibrate the force transducers; discuss the concepts behind the studies on electrical & mechanical properties of skeletal muscle	*Preparation* • Prepare for class as recommended in the document Muscle_lab_prep, guidelines for Day 9 *Calibration (ABL 219)* • Calibrate force transducers and set up Units Conversion (volts to grams) for the nerve/muscle lab; an instruction sheet will be provided so that you can proceed on your own *Student-led discussion (ABL 329)* Please move to the meeting room to begin your discussion after you have finished the calibrations. Have your questions ready for the instructor, if any. Your instructor will join you some time between 2 and 2:15 pm.

	• Discuss motor units and the relationship between tension and compound action potential • Review excitation/contraction coupling in muscle • Discuss the role of calcium in mediating frequency dependent changes in contraction strength • Plan the studies on recruitment and effects of frequency
Day 10 Monday Feb 13, 1 PM Muscle lab 1 ABL 219	Remember to upload your membrane lab discussion before the start of class *Preparation* • Prepare for class as recommended in the document Muscle_lab_prep, guidelines for Day 10 *Laboratory* • Instructor demonstration: nerve/muscle preparation; recording data in "windows" • Prepare nerve & muscle for recording data • Collect data for Treppe, recruitment of motor units, frequency-dependent contractile force (tetanus) *Followup* • Send raw data to the instructor within 24 hours
Day 11 Wednesday Feb 15, 1 PM ABL 219 Muscle lab 2	*Preparation* • Prepare for class as recommended in the document Muscle_lab_prep, guidelines for Day 10 *Laboratory* • Prepare nerve/muscle for recording data • Collect data on isotonic, isometric length-tension relationships and design experiment on fatigue *Followup* • Send raw data to the instructor within 24 hours
Day 12 Monday Feb 20, ABL 329 Follow up muscle labs	*Preparation* • Prepare for class as recommended in the document Muscle_lab_prep, guidelines for Day 11 *Student-led discussion* • Discuss ideas for analyzing and interpreting the recruitment and frequency data • Discuss how to analyze and interpret the length-tension data • [with instructor] Set separate due dates for the second and last results and discussion sections; write up either the nerve studies or the nerve-muscle studies – each individual chooses

Instructor office hours

Week beginning	Monday	Tuesday	Wednesday	Thursday	Friday
Jan 9	11:00 am - 12:30 pm	12:30 - 2:00 pm	office hrs by appt	12:30 - 2:00 pm	office hrs by appt
Jan 16	MLK HOLIDAY	12:30 - 2:00 pm	11:00 am - 12:30 pm	12:30 - 2:00 pm	office hrs by appt
Jan 23	11:00 am - 12:30 pm	12:30 - 2:00 pm	office hrs by appt	12:30 - 2:00 pm	office hrs by appt
Jan 30	11:00 am - 12:30 pm	12:30 - 2:00 pm	11:00 am - 12:30 pm	12:30 - 2:00 pm	office hrs by appt
Feb 6	11:00 am - 12:30 pm	12:30 - 2:00 pm	office hrs by appt	BREAK	BREAK
Feb 13	11:00 am - 12:30 pm	12:30 - 2:00 pm	office hrs by appt	12:30 - 2:00 pm	office hrs by appt
Feb 20	11:00 am - 12:30 pm	12:30 - 2:00 pm	office hrs by appt	office hrs by appt	office hrs by appt
Feb 27	11:00 am - 12:30 pm	office hrs by appt	office hrs by appt	office hrs by appt	office hrs by appt
Mar 6	11:00 am - 12:30 pm	office hrs by appt	11:00 am - 12:30 pm	office hrs by appt	office hrs by appt
Mar 13	SPRING BREAK	SPRING BREAK	SPRING BREAK	SPRING BREAK	SPRING BREAK
Mar 20	office hrs by appt	office hrs by appt	office hrs by appt	office hrs by appt	office hrs by appt
Mar 27	11:00 am - 12:30 pm	office hrs by appt	office hrs by appt	office hrs by appt	office hrs by appt
Apr 3	11:00 am - 12:30 pm	office hrs by appt	office hrs by appt	office hrs by appt	office hrs by appts
Apr 10	11:00 am - 12:30 pm	office hrs by appt	11:00 am - 12:30 pm	office hrs by appt	office hrs by appt
Apr 17	11:00 am - 12:30 pm	office hrs by appt	office hrs by appt	office hrs by appt	office hrs by appt

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